

Indicator: Relative Ecological Condition of Undeveloped Land in Region 5 (206R)

Ecological condition in EPA's Report on the Environment is approached using four questions broadly relating to landscape, biological diversity, ecological function, and the physical and chemical make up of the environment, but no attempt is made at the national level to capture ecological condition in a single index. In this indicator, the ecological condition of undeveloped land in EPA Region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin) is characterized based on an index derived from criteria representing diversity, self-sustainability, and the rarity of certain types of land cover, species, and higher taxa.

A spatially explicit model using ecological theory and geographic information system (GIS) technology was used to create twenty data layers of 300m x 300m cells from 1991-92 NLCD data to generate estimates of the three criteria:

- Ecological Diversity - the relative diversities of populations (species), communities, and ecosystems in any given location on the landscape
- Ecological Self-Sustainability - the potential for an ecosystem to persist for years without external management, and is negatively impacted by two factors: landscape fragmentation and the presence of chemical, physical, and biological stressors
- Rarity - the rarity of land cover, species, and higher taxa.

The model produces composite layers that are statistically independent. The composite score for a criterion is normalized from 1 to 100 so that each contributes equally to the final index, and all of the data layers are weighted equally. Summing the three composite scores results in a final score for each cell. Each undeveloped land cover cell in Region 5 thus is assigned a rating, potentially ranging between 0 and 300. The scores were divided into six categories based on inflections in the derivative of the change in ecosystem scores versus the number of cells. The three categories with the highest rankings (A, B, and C) correspond to approximately 0.1%, 1%, and 10% of the undeveloped area in the Region, respectively (see inset in Figure 206R-1). This analysis could be rerun for the entire US, although the cut points for the categories may vary from one area to the next.

What the Data Show

The majority of undeveloped land in Region 5 lies in along the northern forests of Minnesota, Wisconsin, and Michigan, along the large rivers in Ohio, Indiana, and Illinois (Figure 206R-1). The highest quality (A, B, and C) sites, however, occur in areas that are remote or already protected. As of the 1991 baseline, the total amount of undeveloped land in classes A, B, is approximately 3%, in classes C and D, approximately 68%, and in the poorest classes (E and F), 29% (Histogram, Figure 206R-1). When the 2001-02 NLCD data are available, this analysis can be rerun, and compared to the 1991 data using the same class cut points to detect changes in the amount and ecological quality of undeveloped land in the Region.

Indicator Limitations

- This is a relative comparison of the condition of the undeveloped land within Region 5. The analysis was ranked within ecoregions for some of the indicators in order to account for different geophysical, geochemical and climatic regions.
- An EPA Science Advisory Board review cautioned that the resolution and uncertainty of the results make comparing the ecosystem condition score of one individual cell (300m x 300m) with another inappropriate, but this is not the case for comparison between larger landscapes.

- The model will not be fully field validated to insure that modeled results are reflective of actual ecosystem condition until summer, 2005.
- The ability to track trends will be dependent on the comparability of the 2001 round of the NLCD with the 1991-2 MRLC data used to develop this indicator.

Data Sources

An appendix containing spatial representations of the indicator layers are available at:

http://www.epa.gov/region5/osea/science/CrEAM_appendices.pdf

The metadata for the data used to generate each indicator is available at:

<http://www.epa.gov/region5/osea/science/CrEAMMeta.htm>

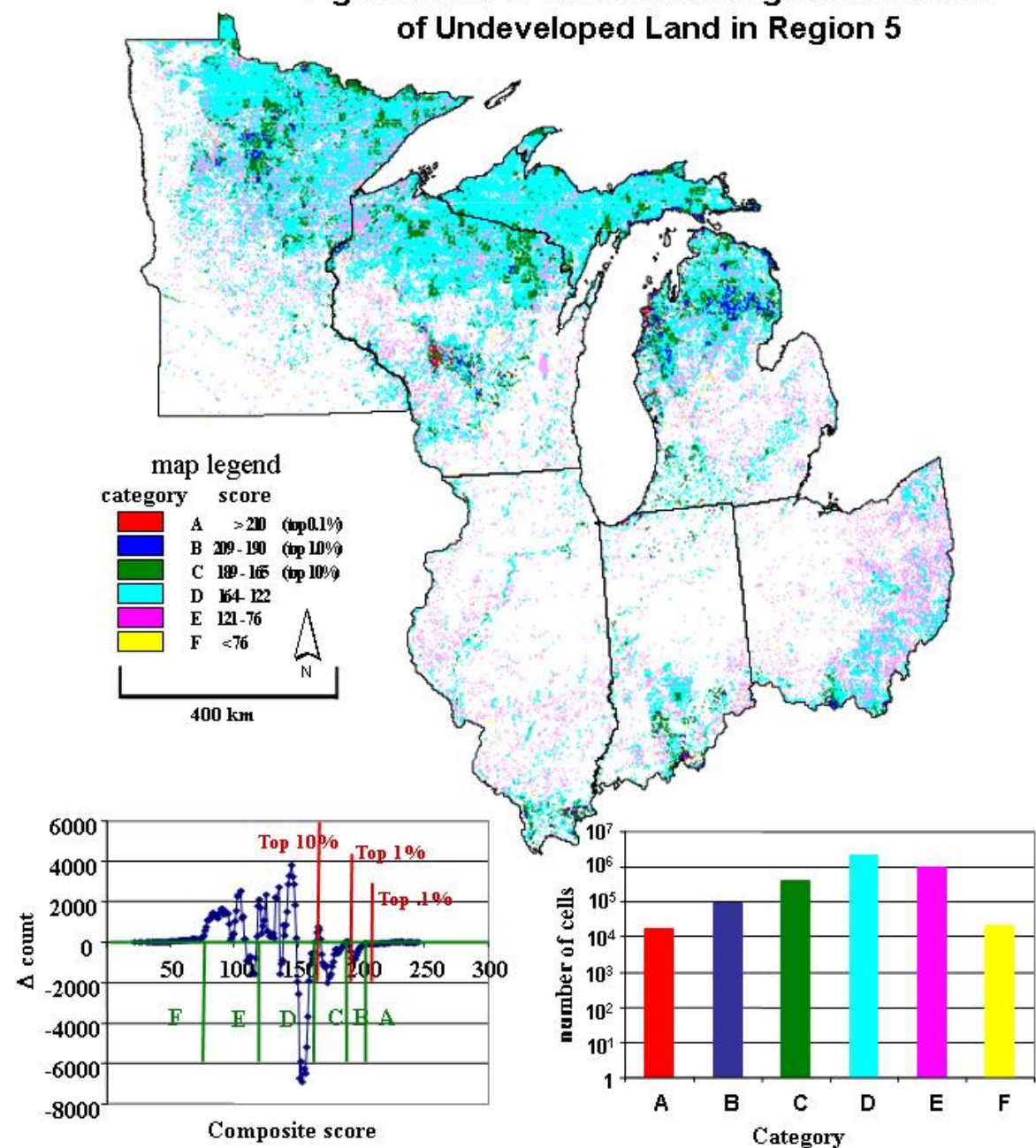
The text explaining the analysis is available at:

http://www.epa.gov/region5/osea/science/CrEAM_text.htm

and the DRAFT Science Advisory Board review of the model and data is available at:

http://www.epa.gov/sab/pdf/cream_report_12_14_04.pdf

Figure 206R-1: Relative Ecological Condition of Undeveloped Land in Region 5



Plotting the first derivative of the frequency curve identifies six categories of ecosystem significance scores. The bins are delineated by green lines and letters (bottom), the top .1, 1 and 10% of the total scores are delineated by red (top).

The study area (top) with composite scores categorized as shown (right). Bar chart shows the number of cells of each category present in 1992, an indicator that can be recalculated for subsequent years and compared to this baseline.

R.O.E. Indicator QA/QC

Data Set Name: RELATIVE ECOLOGICAL CONDITION OF UNDEVELOPED LAND

Indicator Number: 206R (89174)

Data Set Source: primary - National Land Cover Database; secondary - various public access sources

Data Collection Date: irregular: 1992 completed, 2000 in process

Data Collection Frequency: n/a

Data Set Description: Ecological Condition of Undeveloped Land in Region 5

Primary ROE Question: What are the trends in the critical physical and chemical attributes of the Nation's ecological systems?

Comment: The indicator gives a relative ranking of the ecosystem condition of the undeveloped lands in Region 5. The ranking is a composite of chemical, physical and biological properties.

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

The SAB review concluded that for the most part, the measurements are scientifically and technically valid. The draft review (located at http://www.epa.gov/sab/pdf/cream_report_12_14_04.pdf) suggests limits for the use of the indicator based on the quality of data and analysis available at this time. The text is available at: http://www.epa.gov/region5/osea/science/CreAM_text.htm and the appendices are available at: http://www.epa.gov/region5/osea/science/CreAM_appendices.pdf

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

The sampling design was to find already published data that was representative of the 1990-1992 time period and that was consistently collected over the six state region. The DRAFT review addresses data availability and is at: http://www.epa.gov/sab/pdf/cream_report_12_14_04.pdf

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

The DRAFT review is available at: http://www.epa.gov/sab/pdf/cream_report_12_14_04.pdf. In general the reviewers concludes that the data layers do represent the best available data to indicate the ecological phenomenon. They recommend changes to some of them, and if/when the changes can be incorporated the utility of the results will be able to be extended beyond their existing recommendations.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

The ecosystem condition metric which is calculated by the GIS model can answer the question "what was the relative ecological condition of the undeveloped land in Region 5 in 1992?" If the metric is recalculated for the year 2000 data, it can be used to track trends in ecosystem condition between 1992 and 2000. The sample size and location were determined by the National Land Cover Data Base (NLCD) which has a pixel resolution of 30m. Computational limitations necessitated the aggregation (by majority) to a 300m cell size resulting in 3,634,183

cells of undeveloped land. Twenty GIS data layers were used to characterize relative ecological condition. Each data layer has its own resolution which can be found in the metadata at: <http://www.epa.gov/region5/osea/science/CrEAMMeta.htm>

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

One of the three criteria for which a metric is calculated is ecosystem scale rarity.

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

No, this is a relative comparison of the condition of the undeveloped land within Region 5. The analysis was ranked within ecoregions for some of the indicators in order to account for different geophysical, geochemical and climatic regions. It should be noted that the analysis could be rerun using the whole US because the data sets utilized are available nation wide.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

the text is available at: http://www.epa.gov/region5/osea/science/CrEAM_text.htm and the appendices are available at: http://www.epa.gov/region5/osea/science/CrEAM_appendices.pdf

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

Most of the data is in the public domain. The rare and endangered species data which was provided to Region 5 EPA under a confidential business agreement cannot be given out in its original form. We are only allowed to disseminate the summary results. However, with the advent of EcoServ, this data can be obtained through other sources with less restrictions. Metadata files are available at <http://www.epa.gov/region5/osea/science/CrEAMMeta.htm> Contact Dr. Mary White white.mary@epa.gov 312-353-5878

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Methodology is documented in the report submitted to the Science Advisory Board. the text is available at: http://www.epa.gov/region5/osea/science/CrEAM_text.htm and the appendices are available at: http://www.epa.gov/region5/osea/science/CrEAM_appendices.pdf The methodology has been used to evaluate ecosystem condition for the state of Texas. Region 6 was a partner in this effort.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

Methodology is documented in the report submitted to the Science Advisory Board. the text is available at: http://www.epa.gov/region5/osea/science/CrEAM_text.htm and the appendices are available at: http://www.epa.gov/region5/osea/science/CrEAM_appendices.pdf The methodology has been used to evaluate ecosystem condition for the state of Texas. Region 6 was a partner in this effort.

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

Best professional judgement validation has been conducted and the results are favorable. Field validation will take place in the summer of 2005 and statistical summaries of this work will be done then.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Yes, these are described in the Report to the Science Advisory Board.

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

The sensitivity analysis shows that the criteria chosen and the data used to determine a metric for each criteria were robust and non duplicative. One model assumption that would change the results was that all factors were weighted evenly. We have discussed our reasons for this in the report, however if there were compelling evidence and rationale that this should be changed, the results would change.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

The Science Advisory Board review identified limitations in the model as it exists today. They are: results should not be used at the finest resolution (300m x 300m) but rather as a relative comparison between larger landscapes, the results should not be used for individual permitting and enforcement decisions, but rather as a priority determinations in workload allocation, awarding contracts, and ecosystem condition assessment.